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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/732,963

12/11/2003

Andreas Knorr

2003 P 54098 US

9278

48154

7590

03/13/2006

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EXAMINER

ANDUJAR, LEONARDO

ART UNIT

PAPER NUMBER

2826

DATE MAILED: 03/13/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/732,963

Applicant(s)

KNORR ET AL.

Examiner

Leonardo Andújar

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 December 2005.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-34 is/are pending in the application.
- 4a) Of the above claim(s) 18-34 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-17 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>12/03/3/04 and 6/04</u> . | 6) <input checked="" type="checkbox"/> Other: <u>IDS 2/05, 9/05 and 12/05</u> . |

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of group I (claims 1-17) in the reply filed on 12/22/2006 is acknowledged.

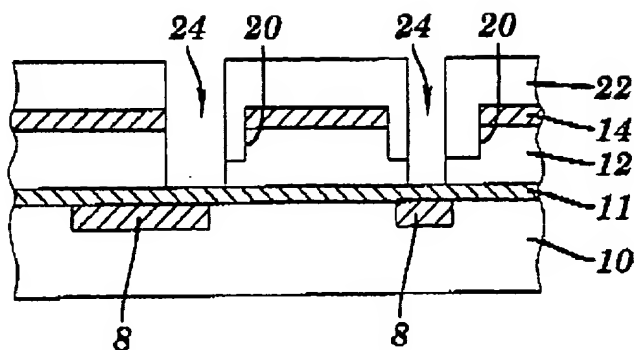
Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1-7 and 11-15 are rejected under 35 U.S.C. 102(b) as being anticipated by Biolsi et al. (US 6,444,557).
4. Regarding claim 1, Biolsi (e.g. figs. 1-13) teaches a method of fabricating a semiconductor device, the method comprising: providing a workpiece; depositing a porous dielectric material 12 (e.g. MSQ; silica aerogel) over the workpiece 10 (e.g. fig. 1; col. 4/lls. 61-67); forming a pattern in the porous dielectric material (fig. 6a), the pattern 20 comprising sidewalls; depositing a photosensitive material 22 over the porous dielectric material (e.g. fig. 9a), wherein the photosensitive material forms a barrier region of photosensitive material within and over the sidewalls of the pattern in the porous dielectric material; and developing the photosensitive material (col. 6/lls. 50-61).

**FIG. 9a**

5. Regarding claim 2, Biolsi shows that the pattern in the pours dielectric material comprise a single damascene pattern.

6. Regarding claims 3-5, Biolsi shows that the porous dielectric material is a low dielectric constant material having a dielectric constant less than 3. Note that MSQ or silica aerogel have dielectric constant less than 3 (inherent property material).

7. Regarding claim 6, Biolsi teaches that the step of depositing a photosensitive material comprises spinning on a material compatible with the porous dielectric layer (col. 6/lis. 52-53).

8. Regarding claim 7, Biolsi teaches that the step of depositing the porous material comprises depositing a porous methylsilsequioxane MSQ (col. 4/lis. 65). Note that the MSQ is inherently porous (inherent property of the material).

9. Regarding claim 8, Biolsi teaches that a layer 22 is photosensitive. Although not explicitly taught layer 22 must be either organic or inorganic. Note that these are the two major material categories.

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10. Regarding claims 11 and 12, Biolsi shows that the photosensitive material comprises exposing the work to UV light (e.g. DUV light) in 248 nm wavelength (col. 5/lls. 45-60 & col. 6/lls. 50-60).

11. Regarding claims 13 and 14, Biolsi teaches the step of depositing a liner over the porous dielectric material and a barrier region of photosensitive material and depositing a conductive material 26 (e.g. copper) over the liner to fill the patten in the porous material (col. 7/lls. 10-39). The barrier region of photosensitive material is interpreted as the region that was previously in contact with the photosensitive material 22.

12. Regarding claim 15, Biolsi teaches that the photosensitive material is removed from the patterned porous dielectric after developing the photosensitive material (col. 6/lls. 50-61 & col. 7/lls. 10-12).

Claim Rejections - 35 USC § 103

13. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

14. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biolsi et al. (US 6,444,557) in view of Yu et al. (US 6,593,220).

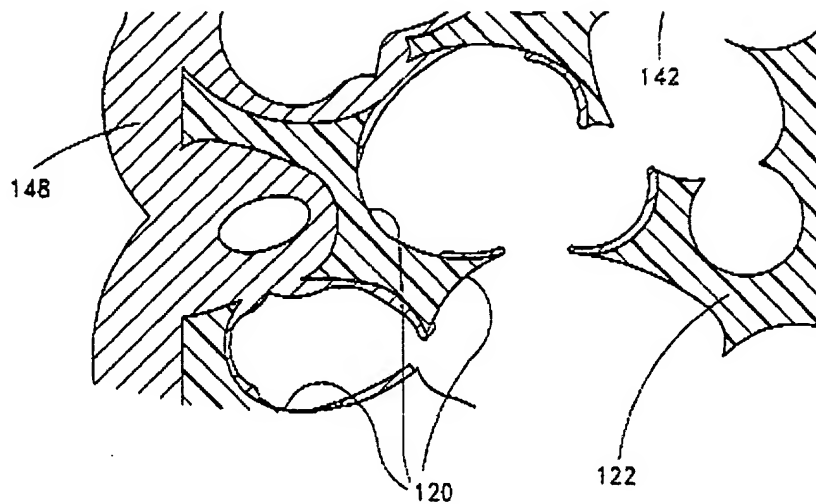
15. Regarding claim 8, Biolsi teaches the step of depositing a photosensitive material 22 (i.e. photoresist) but does not disclose the specific compound used for the photosensitive layer or its nature. Therefore, Biolsi does not explicitly suggest that the photosensitive material comprises depositing photosensitive polyimide, photosensitive

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organic material, a photosensitive inorganic material or benzocyclobutane BCB. Yu teaches that photoresists are typically made of polymers such as photosensitive polyimide because this material can be deposited by a simple process and tolerates high temperatures (col. 9/lls. 36-39; col. 10/lls. 39-40 & col. 11/lls. 1-25). It would have been obvious to one having ordinary skill in the art at the time the invention was made to make the layer 22 disclosed by Biolsi of photosensitive polyimide since this material can be deposited by simple processes and can tolerate high temperature. Also, it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. In re Leshin, 125 USPQ 416.

16. Claims 9, 10, 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Biolsi et al. (US 6,444,557) in view of Raaijmakers et al. (US 2001/0054769).

17. Regarding claim 9, Biolsi teaches most aspects of the instant invention including a porous dielectric material including a plurality of pores (inherent property of the material) but does not teach that the photosensitive material is soaked into the sidewalls of the porous dielectric material pattern about one or two pores. Nonetheless, Raaijmakers (10b) teaches a sealing layer 148 soaking the sidewalls of a porous dielectric material pattern about one pore. This embodiment provides a near perfect coverage step which allows a minimal thickness for a diffusion barrier function, thereby maximizing the volume of a subsequent filling metal for any given trench and via dimension (abstract).

*Fig. 10b*

It would have been obvious to one having ordinary skill in the art at the time the invention was made to soak the photosensitive material disclosed by Biolsi into the sidewalls of the porous dielectric material pattern about one pore as suggested by Raaijmakers to provide a near perfect step coverage, allowing a minimal thickness for a diffusion barrier function, thereby maximizing the volume of a subsequent metal filling of the via.

18. Regarding claim 10, Biolsi teaches most aspects of the instant invention including a porous dielectric material including a plurality of pores (inherent property of the material) but does not teach that the photosensitive material is soaked into the sidewalls of the porous dielectric material pattern about 50 angstroms or less. Nonetheless, Raaijmakers (10b) teaches a sealing layer 148 soaking the sidewalls of a porous dielectric material pattern about one pore ($\approx 4\text{nm}$). This embodiment provides a near perfect coverage step which allows a minimal thickness for a diffusion barrier function, thereby maximizing the volume of a subsequent filling metal for any given

trench and via dimension (abstract & pp 0057). It would have been obvious to one having ordinary skill in the art at the time the invention was made to soak the photosensitive material disclosed by Biolsi into the sidewalls of the porous dielectric material pattern about one pore ($\approx 4\text{nm}$) as suggested by Yu to provide a near perfect step coverage, allowing a minimal thickness for a diffusion barrier function, thereby maximizing the volume of a subsequent metal filling of the via.

19. Regarding claims, 16 and 17, Biolsi does not explicitly teach the step of depositing an etch stop layer over the porous material, before forming the pattern in the porous dielectric layer material wherein the etch stop layer comprises about 100 to 1000 angstroms of a silicon carbon based material, a carbon-nitride material, a spin-on cap material, silicon nitride, silicon oxides, other insulating materials, a metal, or combinations thereof. Nevertheless, Raaijmakers shows the step of depositing an etch stop layer over the porous material, before forming the pattern in the porous dielectric layer material wherein the etch stop layer comprises about 100 to 1000 angstroms of a silicon nitride to strengthen the underlying dielectric layer (pp 0058). It would have been obvious to one having ordinary skill in the art at the time the invention was made to include the step of depositing an etch stop layer over the porous material and before forming the pattern in the porous dielectric layer material disclosed by Biolsi wherein the etch stop layer comprises about 100 to 1000 angstroms of a silicon nitride to strengthen the dielectric layer as taught by Raaijmakers.

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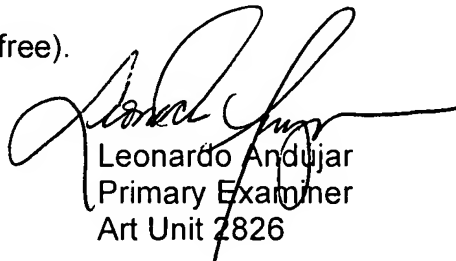
Conclusion

20. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Jain shows processes similar to the instant invention whereas Wolf teaches properties of typical low dielectric materials.

21. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Leonardo Andújar whose telephone number is 571-272-1912. The examiner can normally be reached on Mon through Thu from 9:00 AM to 7:30 PM EST.

22. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J. Flynn can be reached on 571-272-1915. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Leonardo Andujar
Primary Examiner
Art Unit 2826

02/28/2006